Fig. 1

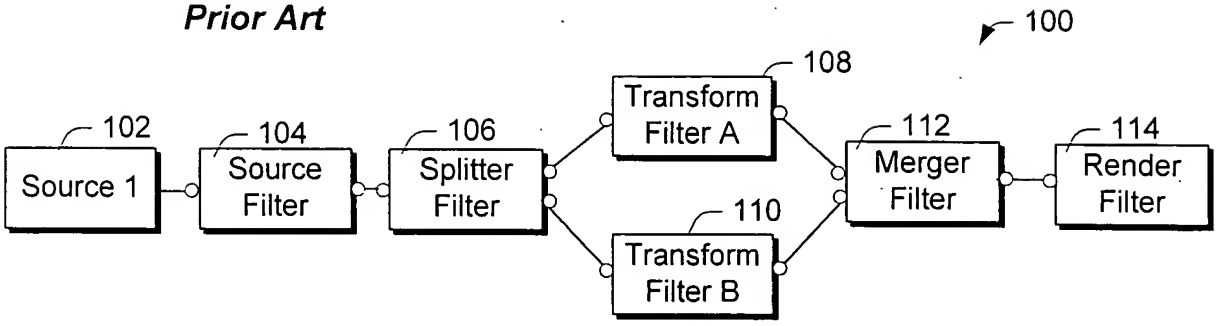
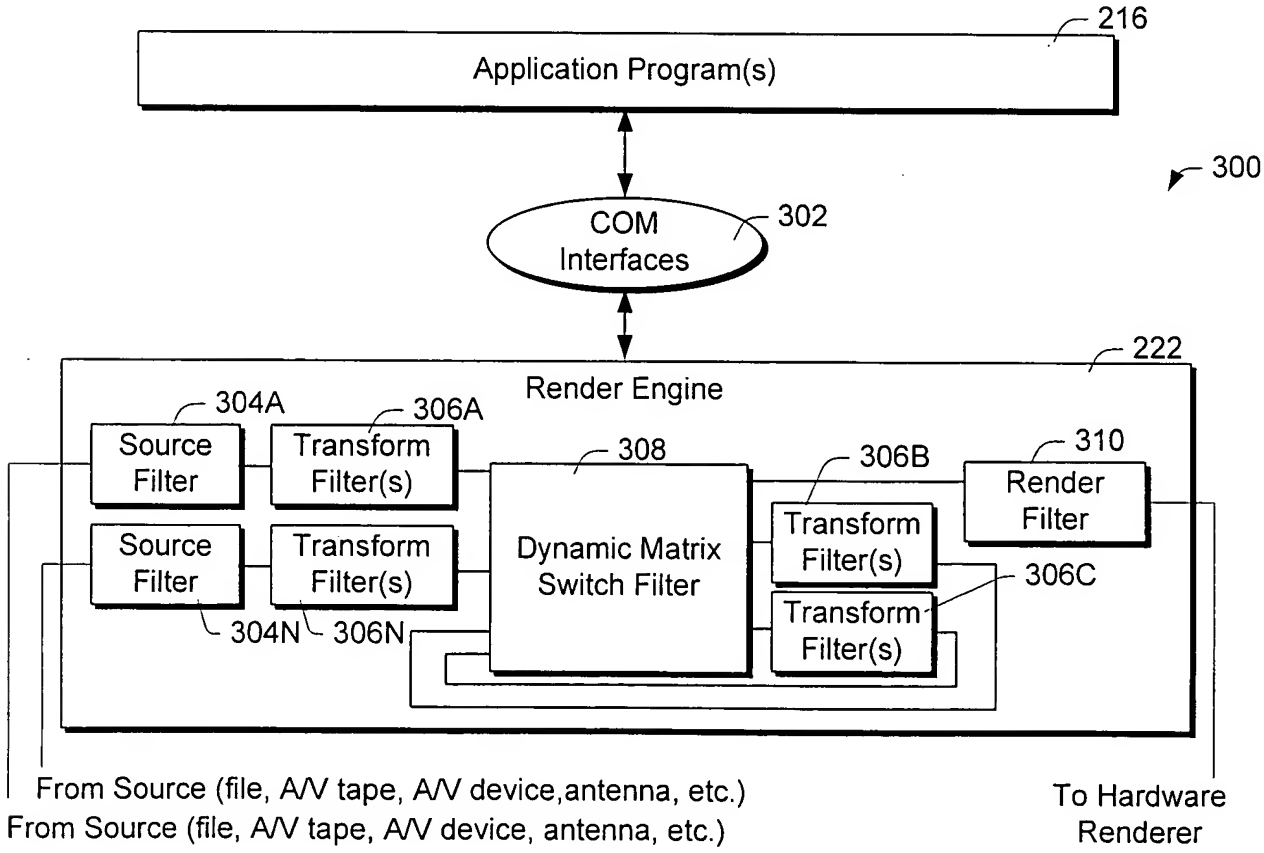

Prior Art
100
102
Source 1
104
Source Filter
106
Splitter Filter
108
Transform Filter A
110
Transform Filter B
112
Merger Filter
114
Render Filter

Fig. 3


216
Application Program(s)
300
COM Interfaces
302
222
Render Engine
304A
Source Filter
306A
Transform Filter(s)
Source Filter
Transform Filter(s)
304N
306N
308
Dynamic Matrix Switch Filter
306B
Transform Filter(s)
Transform Filter(s)
306C
310
Render Filter
From Source (file, A/V tape, A/V device,antenna, etc.)
From Source (file, A/V tape, A/V device, antenna, etc.)
To Hardware Renderer

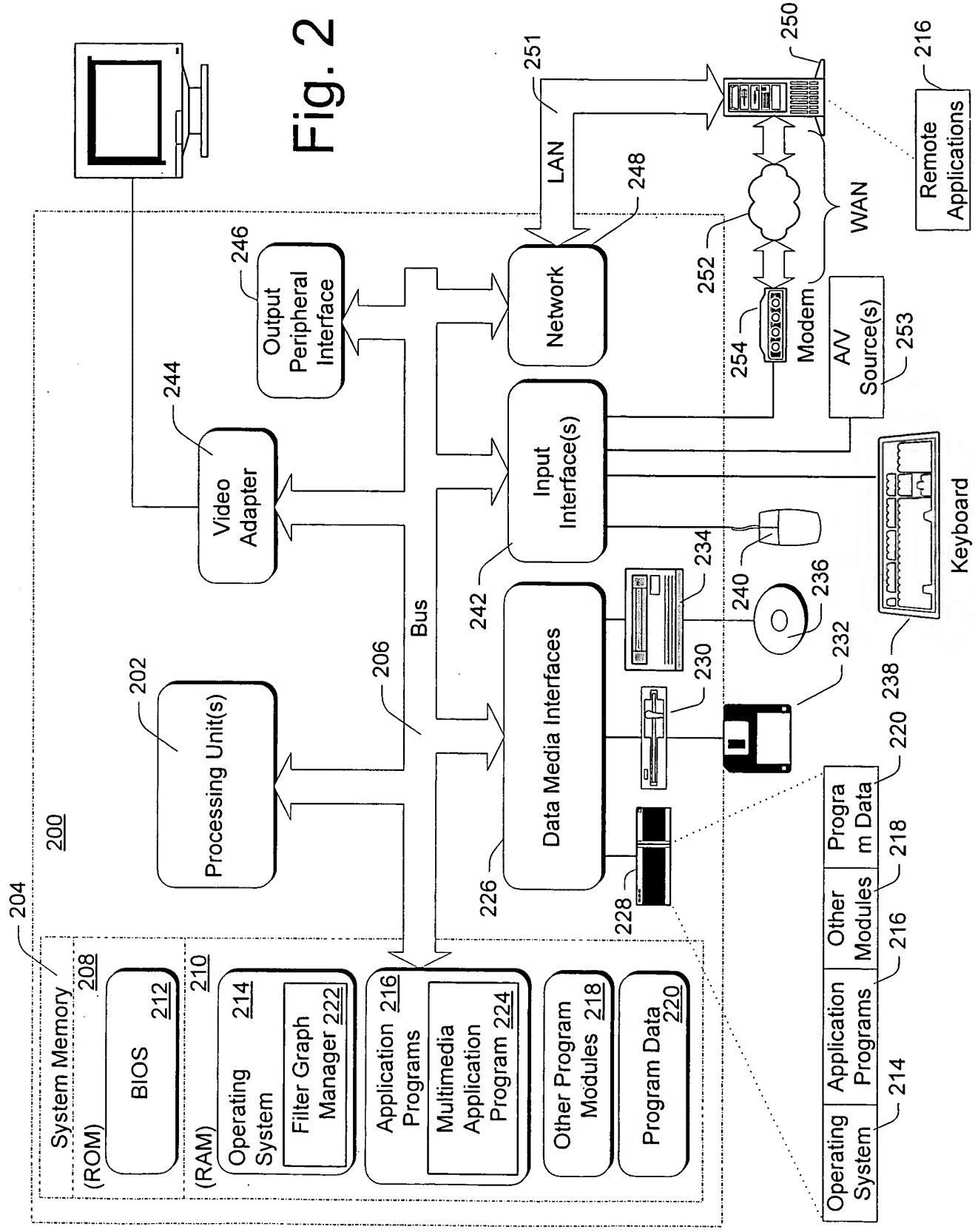
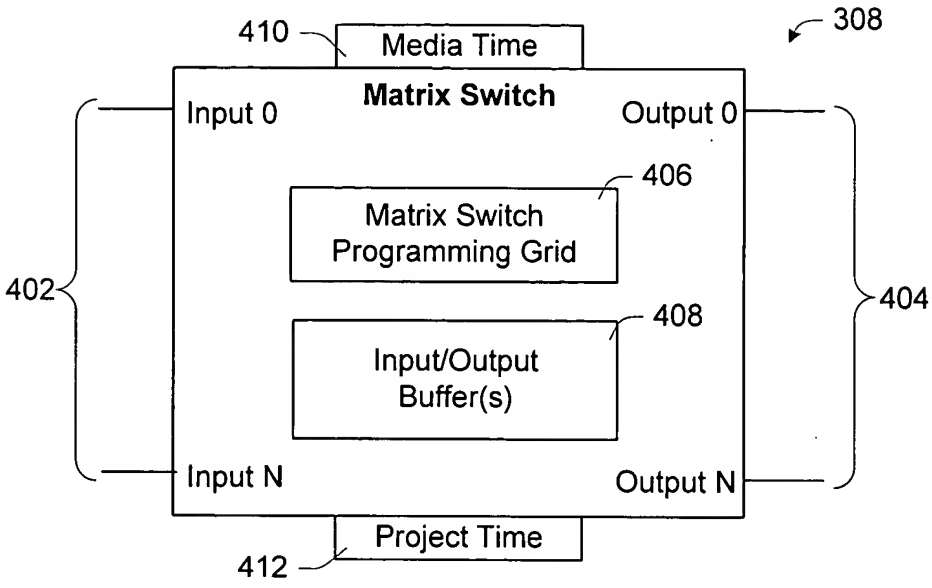

200
204
System Memory
208
(ROM)
BIOS
212
210
(RAM)
Operating System
214
Filter Graph Manager
222
Application Programs
216
Multimedia Application Program
224
Other Program Modules
218
Program Data
220
Processing Unit(s)
202
206
Bus
Video Adapter
244
Output Peripheral Interface
246
Network
248
LAN
251
WAN
252
Modem
254
A/V Source(s)
253
Input Interface(s)
242
Data Media Interfaces
226
228
230
232
234
236
238
240
Keyboard
250
Remote Applications
216
Operating System
214
Application Programs
216
Other Modules
218
Program Data
220

Fig. 2

Fig. 4


410
Media Time
308
Matrix Switch
Input 0
Output 0
406
Matrix Switch Programming Grid
402
404
408
Input/Output Buffer(s)
Input N
Output N
Project Time
412

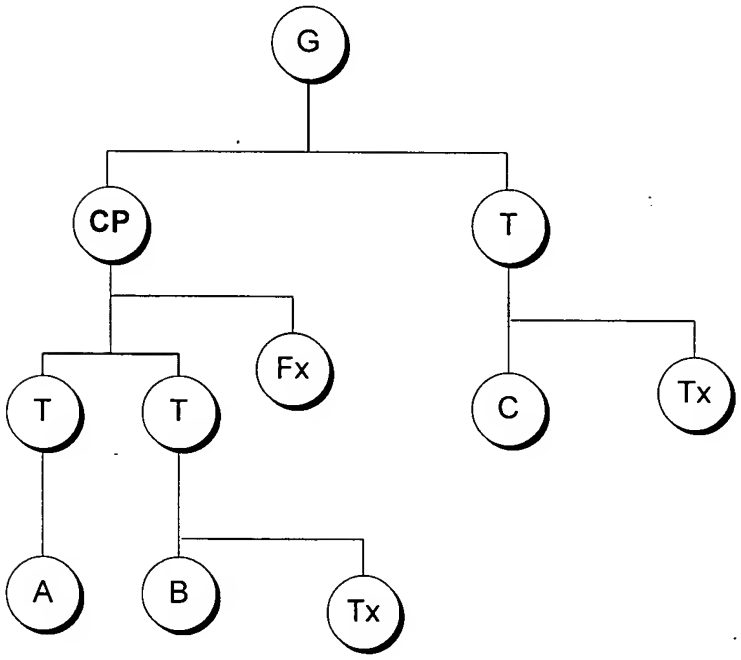

G
CP
T
Fx
T
T
C
Tx
A
B
Tx

Fig.38a

Fig. 5

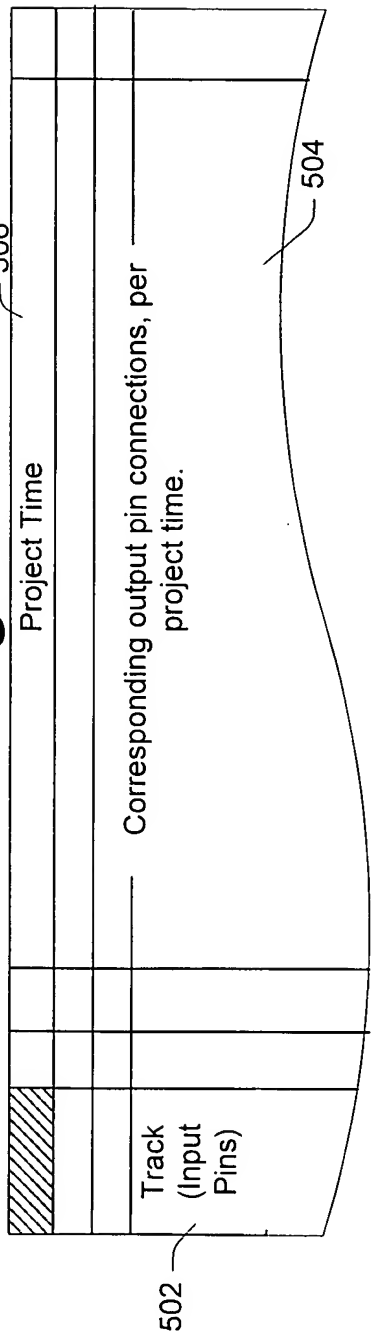

406
506
504
Project Time
Corresponding output pin connections, per project time.
Track (Input Pins)
502

Fig. 6

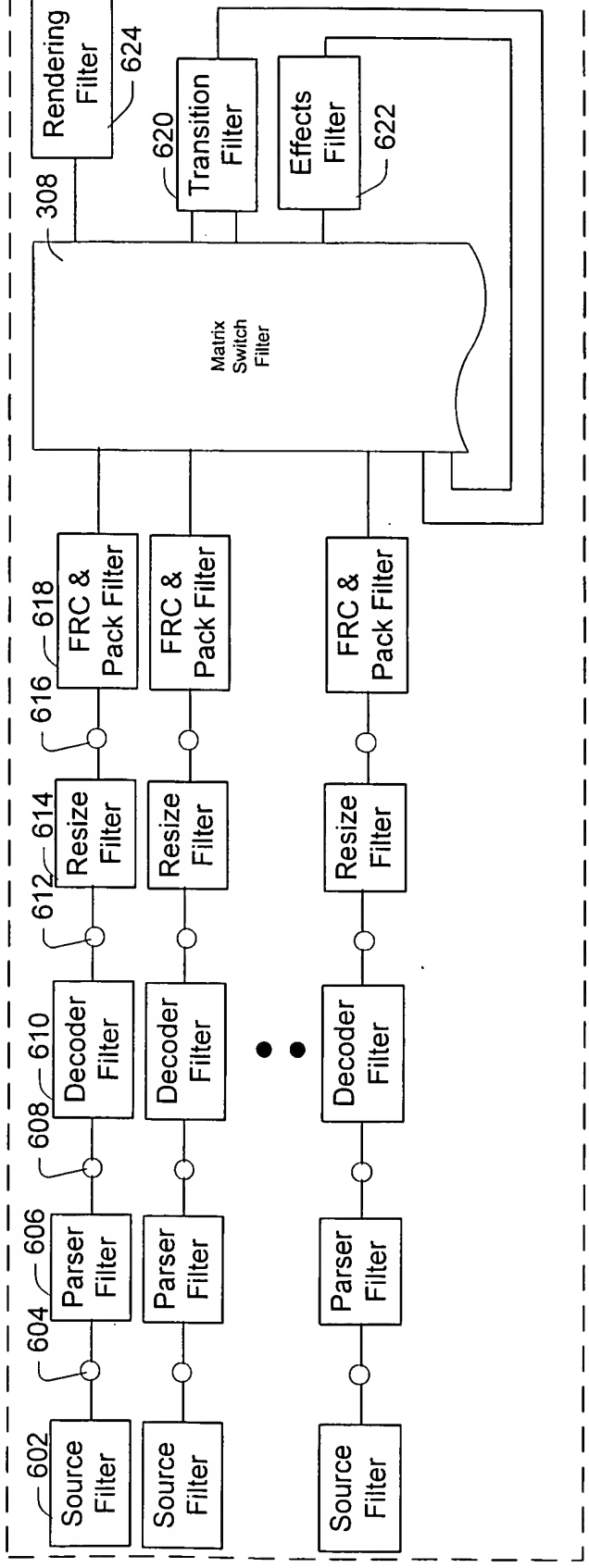

600
Rendering Filter
624
Transition Filter
620
Effects Filter
622
308
Matrix Switch Filter
FRC & Pack Filter
618
Resize Filter
614
Decoder Filter
610
Parser Filter
606
Source Filter
602
616
612
608
604

Fig. 7

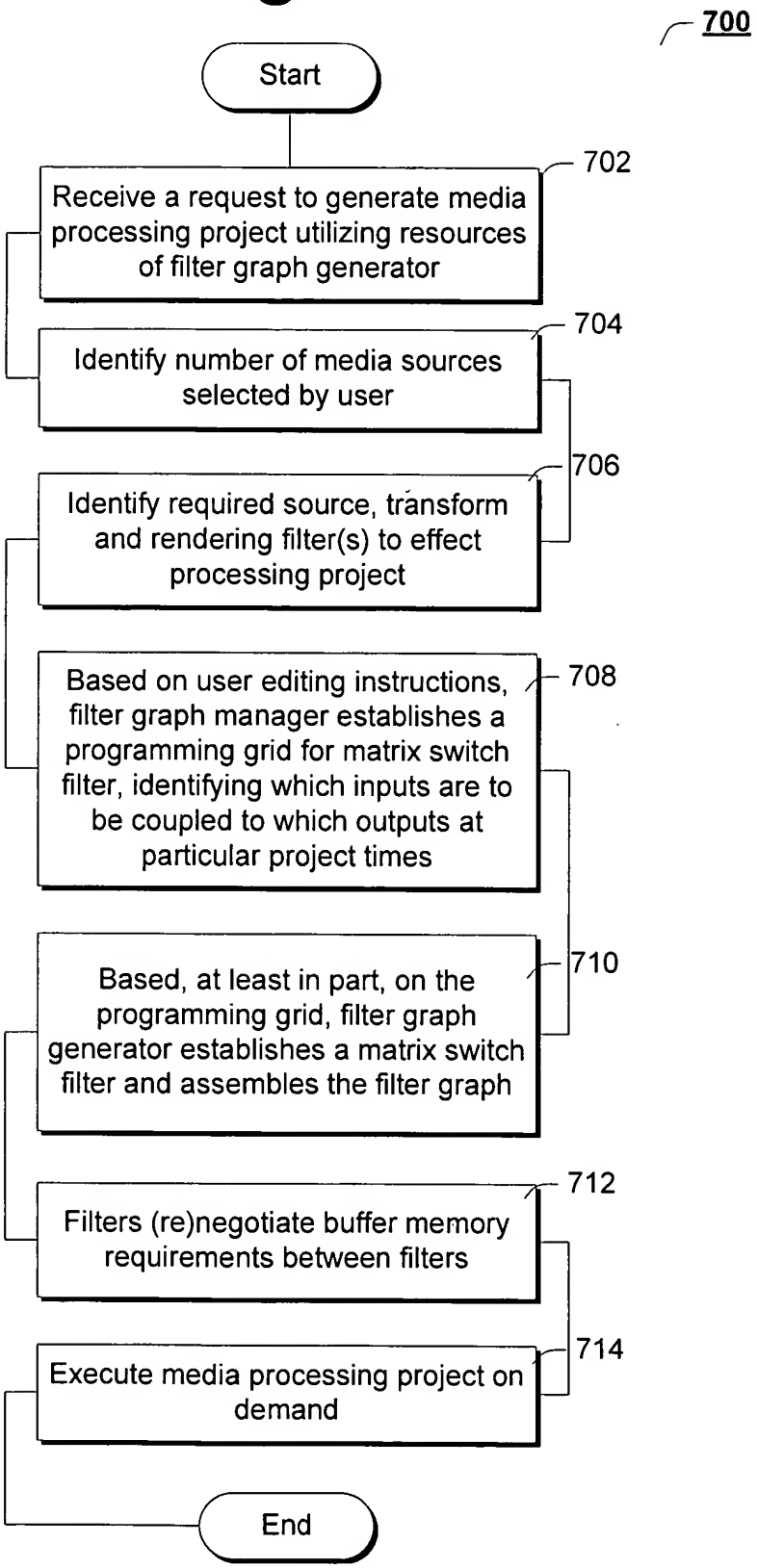
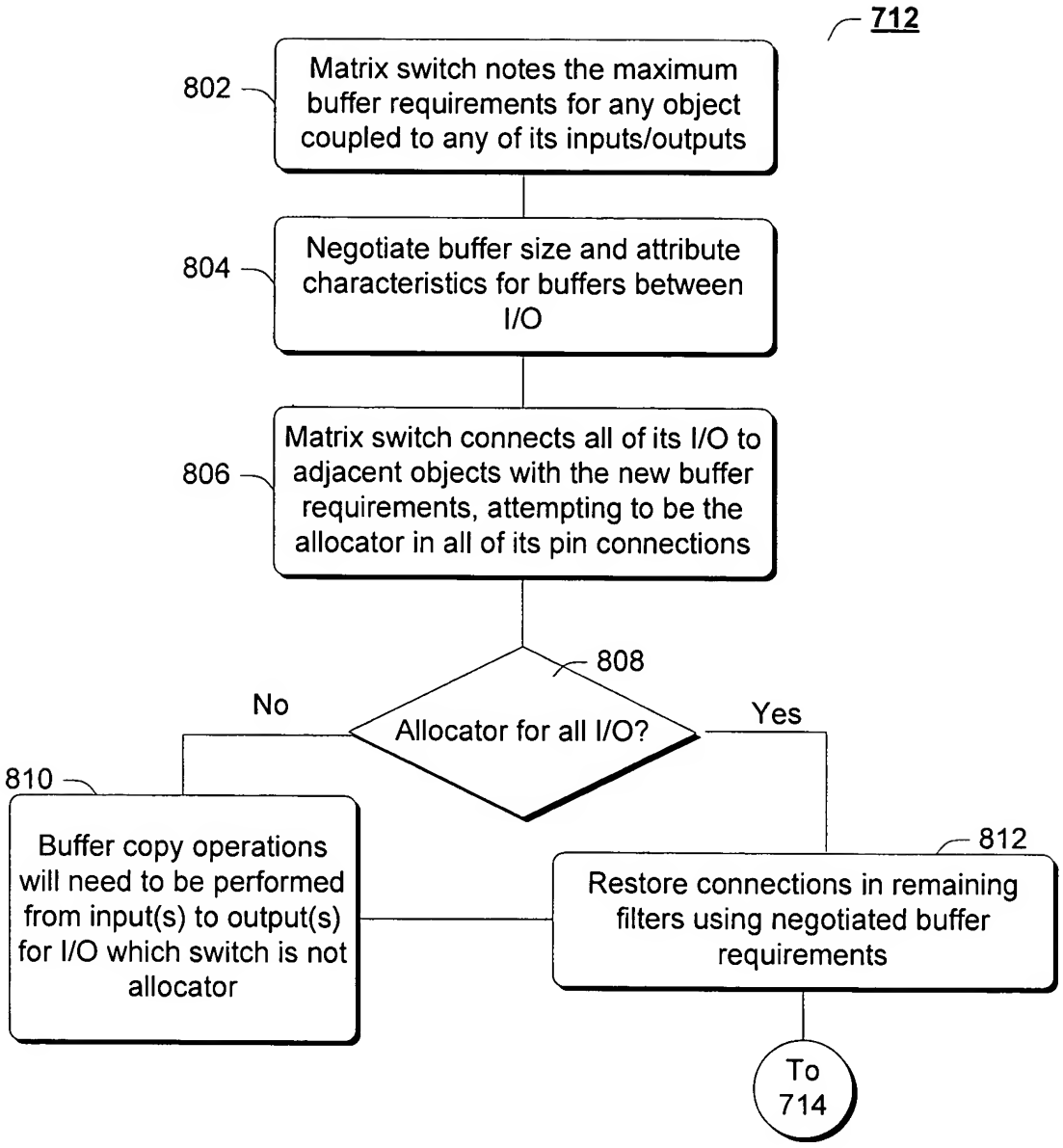

700
Start
Receive a request to generate media processing project utilizing resources of filter graph generator
702
Identify number of media sources selected by user
704
Identify required source, transform and rendering filter(s) to effect processing project
706
Based on user editing instructions, filter graph manager establishes a programming grid for matrix switch filter, identifying which inputs are to be coupled to which outputs at particular project times
708
Based, at least in part, on the programming grid, filter graph generator establishes a matrix switch filter and assembles the filter graph
710
Filters (re)negotiate buffer memory requirements between filters
712
Execute media processing project on demand
714
End

Fig. 8


712
802
Matrix switch notes the maximum buffer requirements for any object coupled to any of its inputs/outputs
804
Negotiate buffer size and attribute characteristics for buffers between I/O
806
Matrix switch connects all of its I/O to adjacent objects with the new buffer requirements, attempting to be the allocator in all of its pin connections
808
Allocator for all I/O?
No
Yes
810
Buffer copy operations will need to be performed from input(s) to output(s) for I/O which switch is not allocator
812
Restore connections in remaining filters using negotiated buffer requirements
To 714

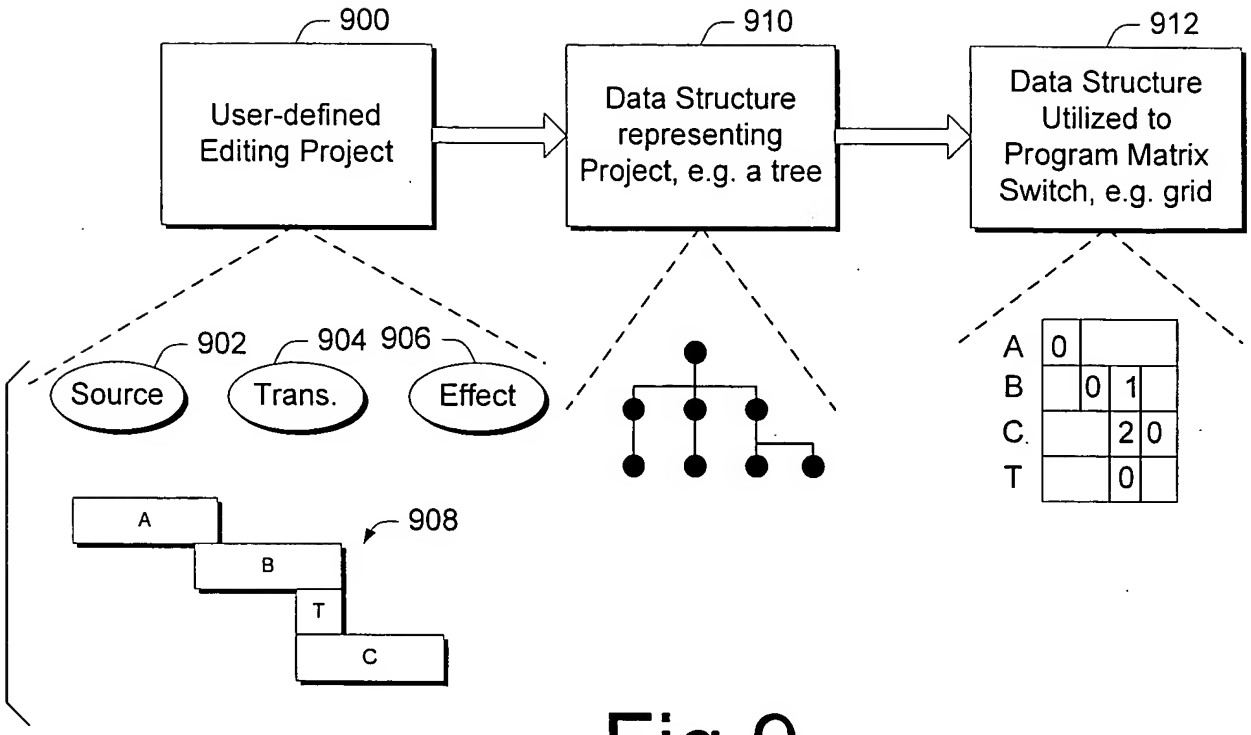

900
User-defined Editing Project
910
Data Structure representing Project, e.g. a tree
912
Data Structure Utilized to Program Matrix Switch, e.g. grid
902
904
906
Source
Trans.
Effect
A
B
T
C
908
A 0
B 0 1
C 2 0
T 0

Fig.9

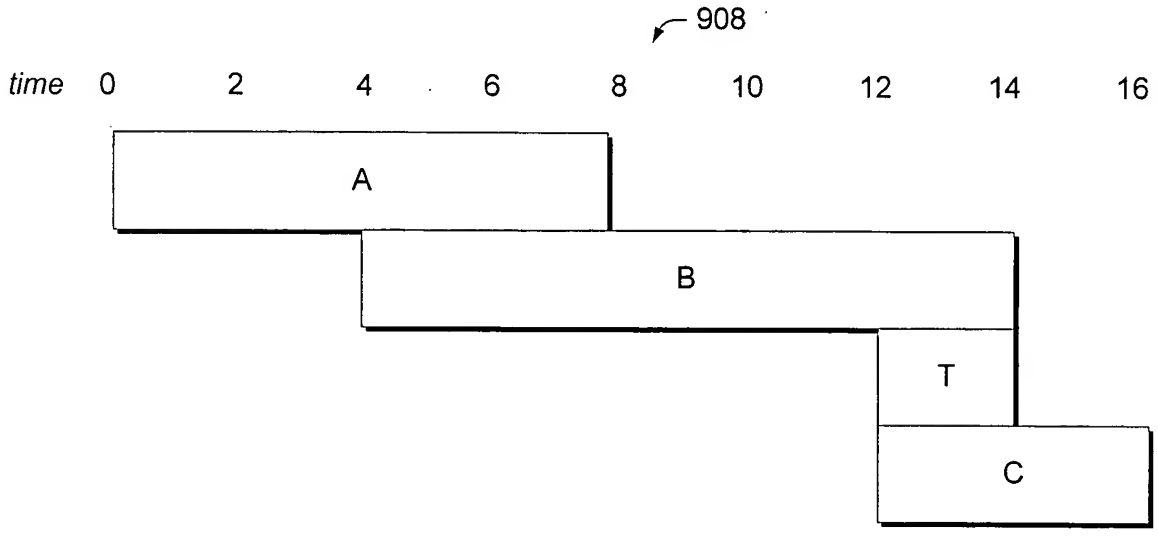

908
time 0 2 4 6 8 10 12 14 16
A
B
T
C

Fig.10

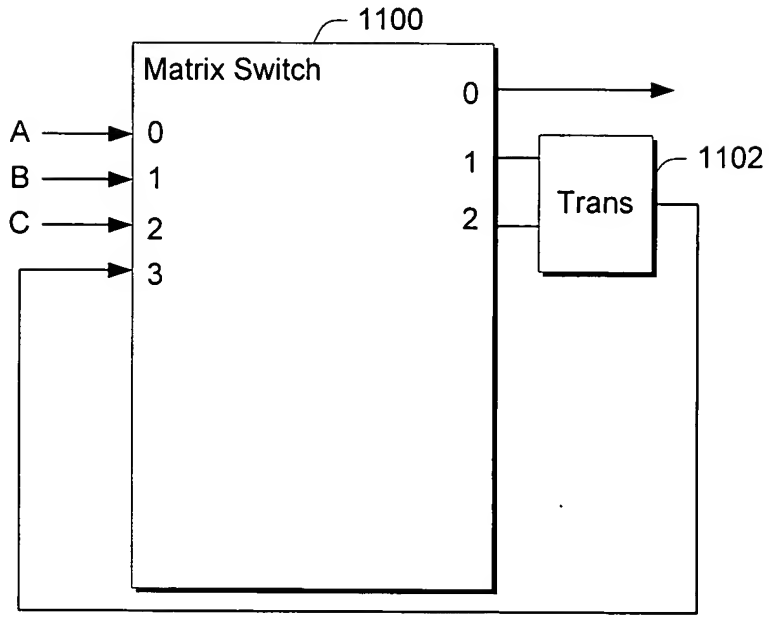

1100
Matrix Switch
A
B
C
0
1
2
3
0
1
2
Trans
1102

Fig.11

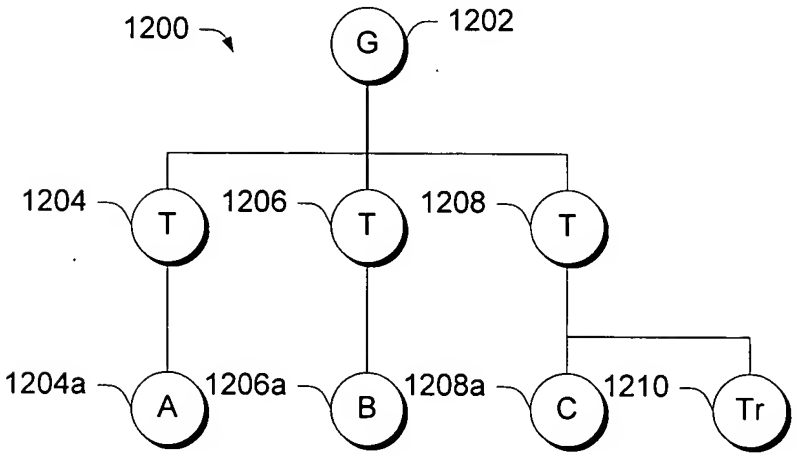

1200
G
1202
1204
T
1206
T
1208
T
1204a
A
1206a
B
1208a
C
1210
Tr

Fig.12

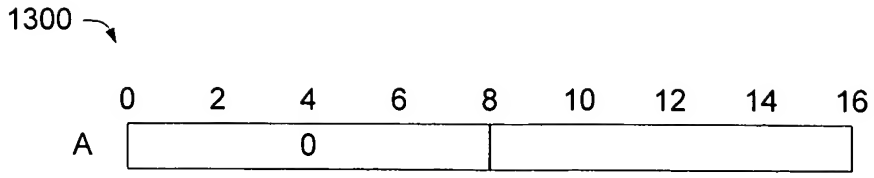


Fig.13

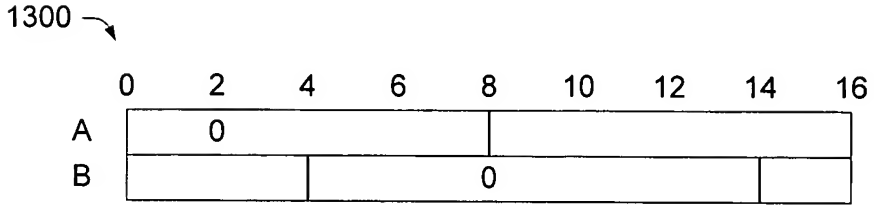


Fig.14

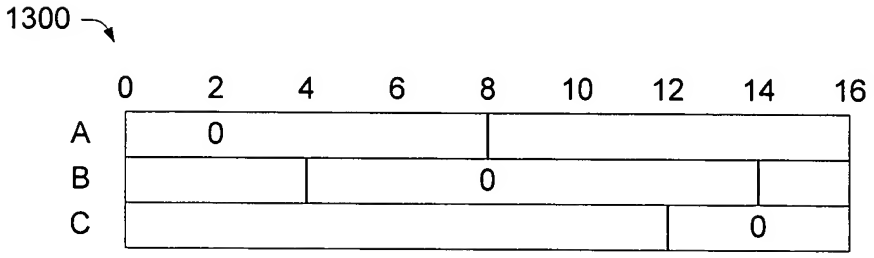


Fig.15

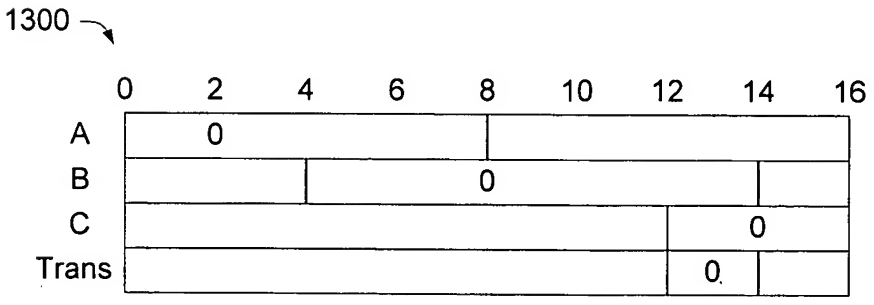


Fig.16

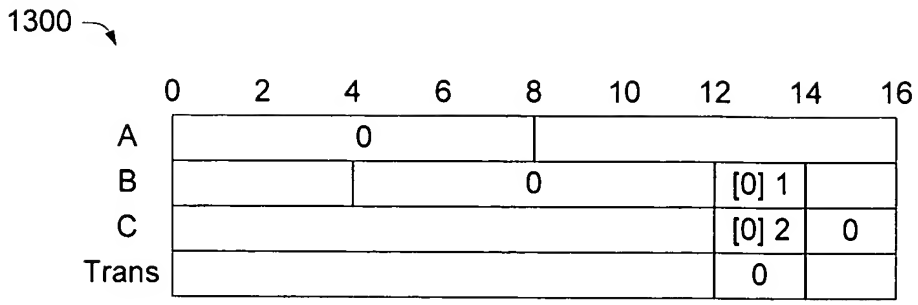

1300
0 2 4 6 8 10 12 14 16
A
B
C
Trans
0
0
[0] 1
[0] 2
0
0

Fig.17

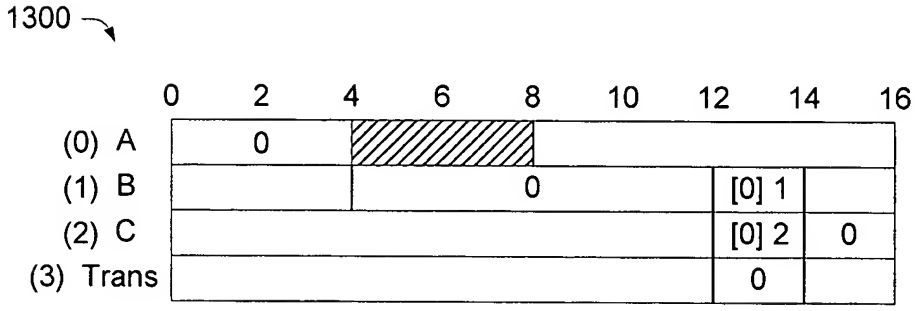

1300
0 2 4 6 8 10 12 14 16
(0) A
(1) B
(2) C
(3) Trans
0
0
[0] 1
[0] 2
0
0

Fig.18

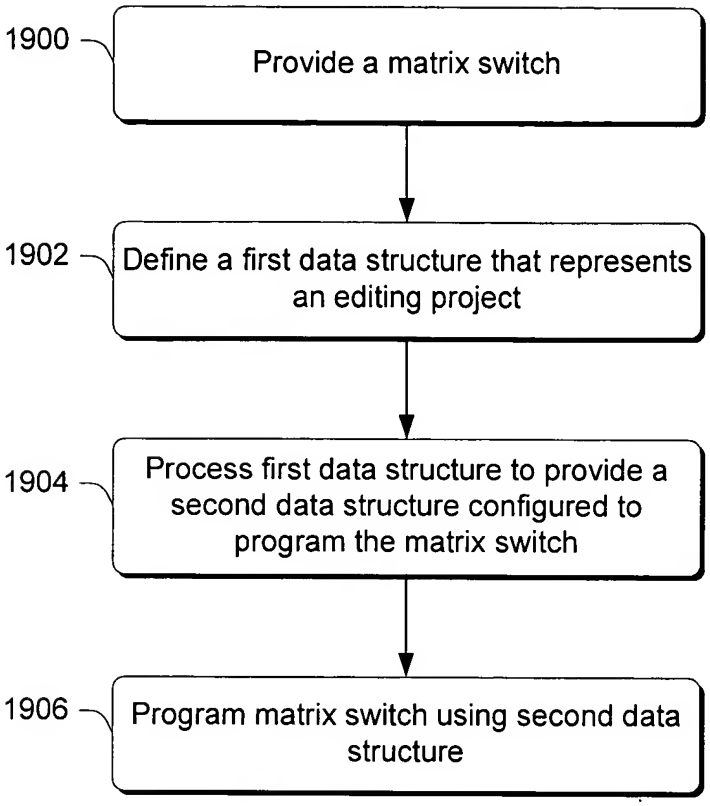

1900
Provide a matrix switch
1902
Define a first data structure that represents an editing project
1904
Process first data structure to provide a second data structure configured to program the matrix switch
1906
Program matrix switch using second data structure

Fig.19

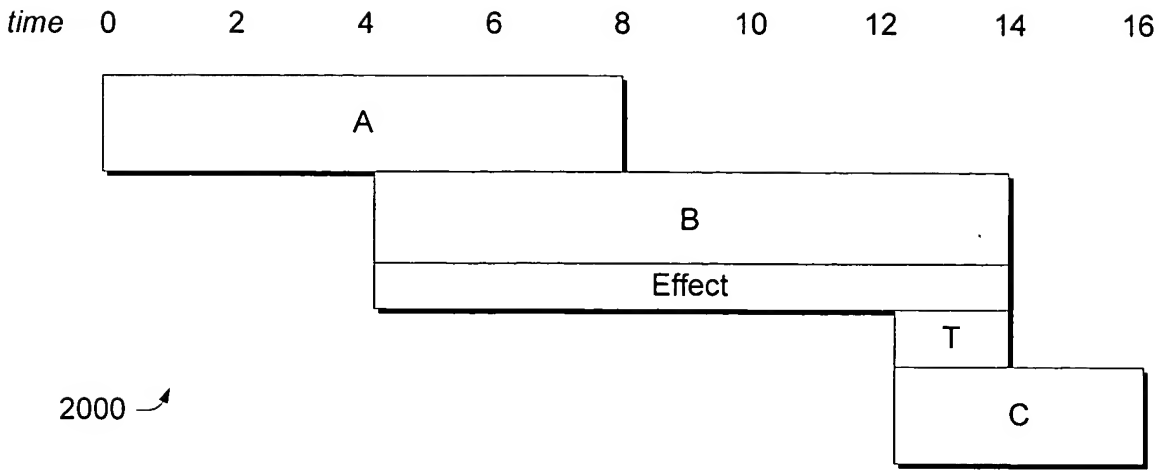


Fig.20

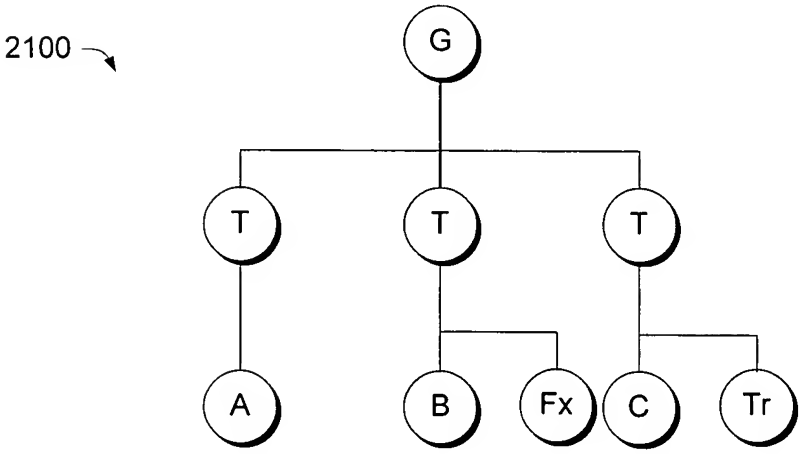


Fig.21

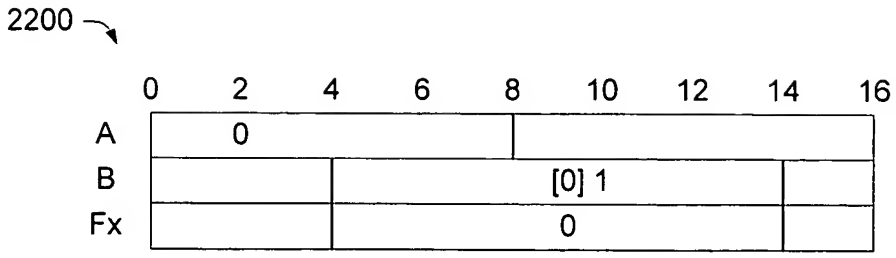


Fig.22

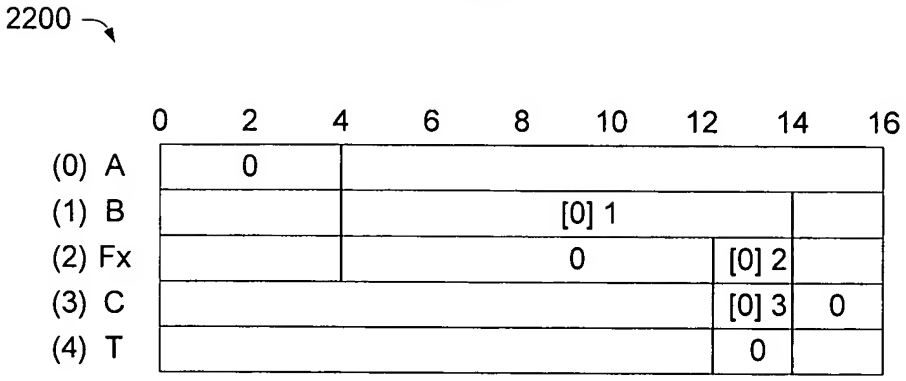


Fig.23

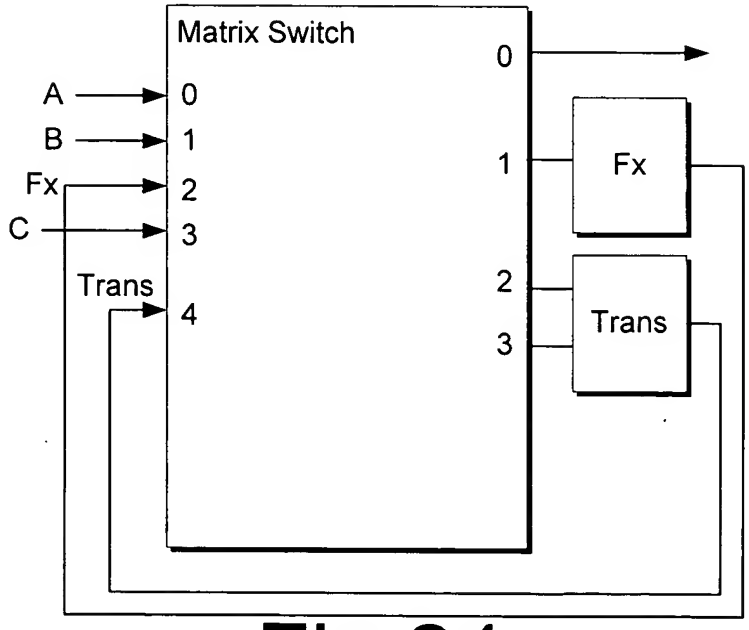


Fig.24

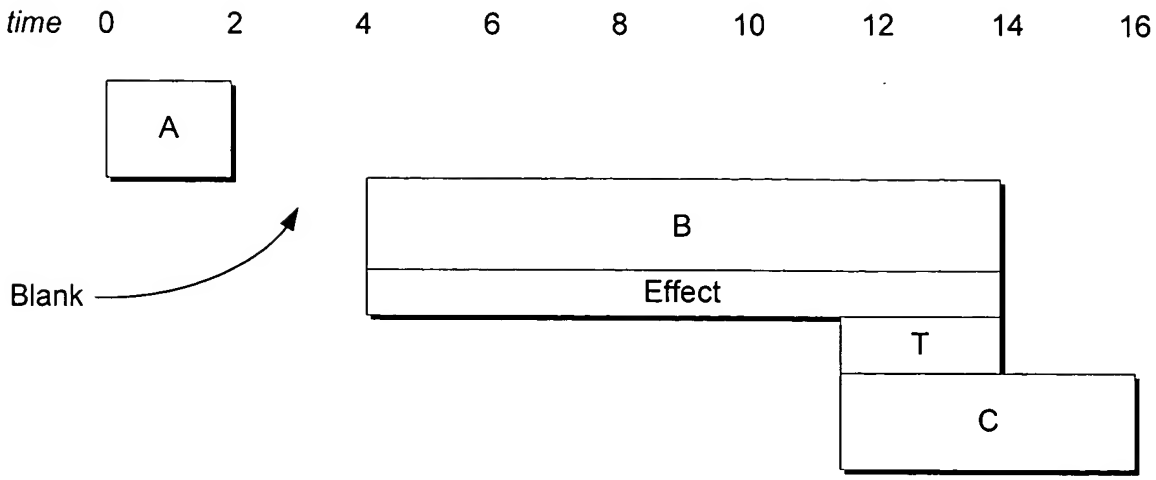

time
0
2
4
6
8
10
12
14
16
A
B
Effect
T
C
Blank

Fig.25

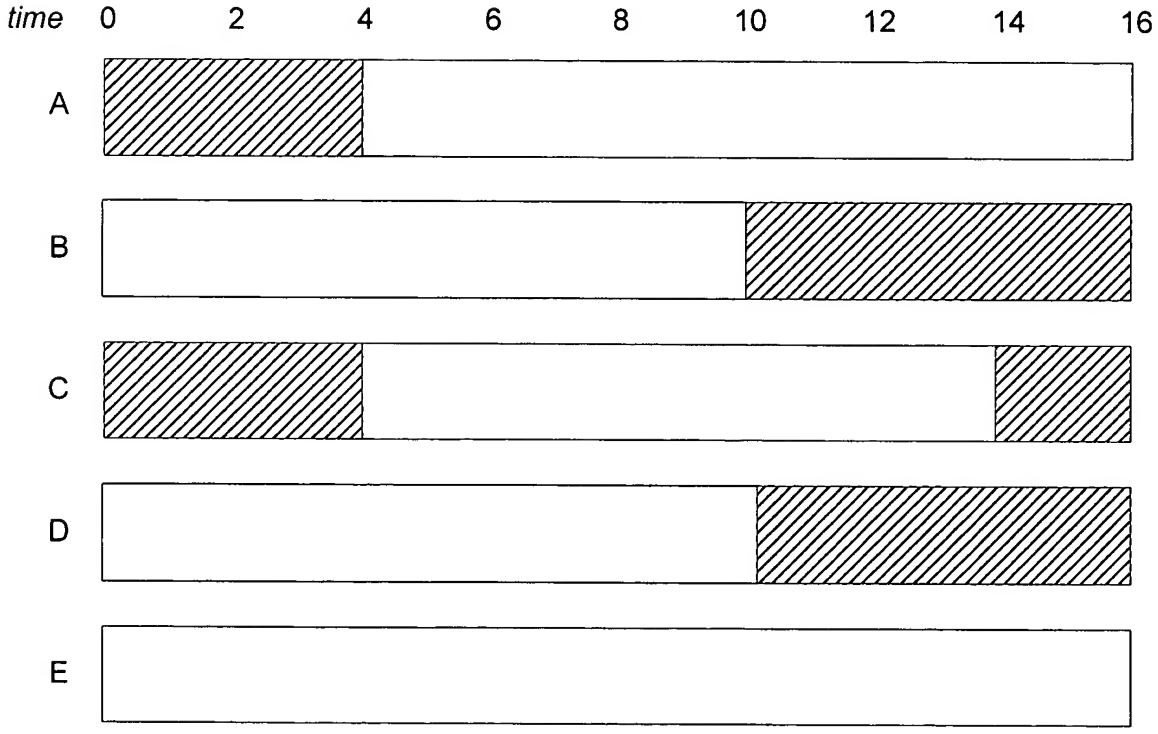

time
0
2
4
6
8
10
12
14
16
A
B
C
D
E

Fig.26

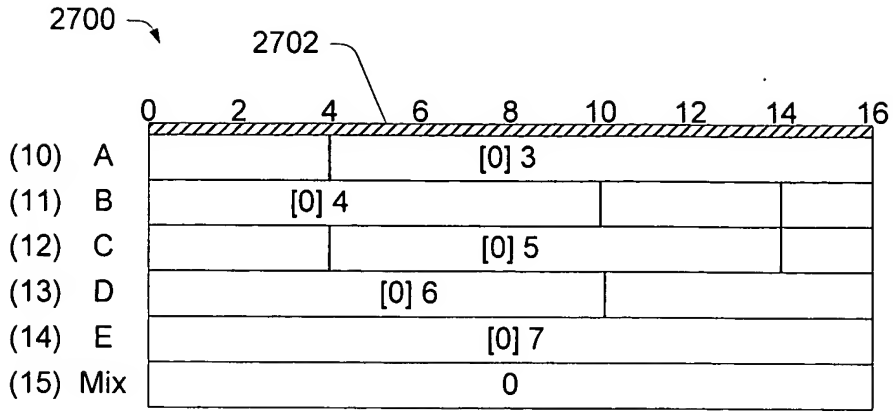

2700
2702
0
2
4
6
8
10
12
14
16
(10) A
(11) B
(12) C
(13) D
(14) E
(15) Mix
[0] 3
[0] 4
[0] 5
[0] 6
[0] 7
0

Fig.27

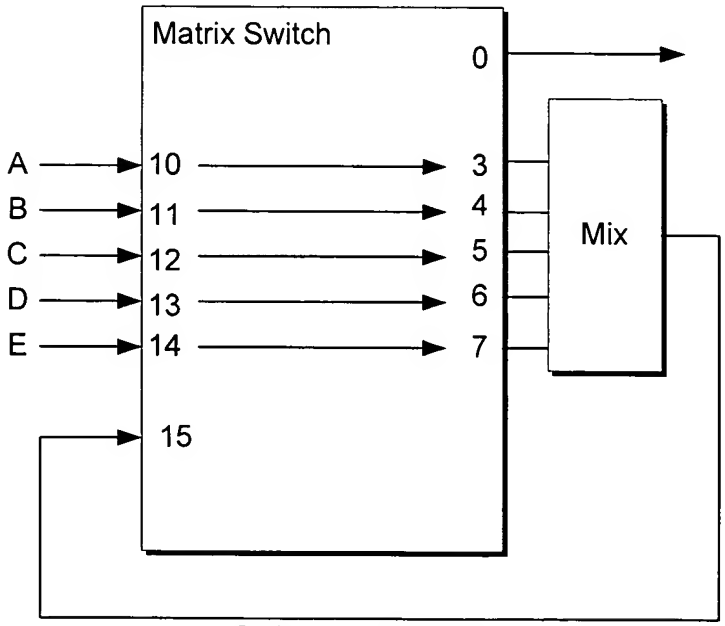

Matrix Switch
0
A
B
C
D
E
10
11
12
13
14
15
3
4
5
6
7
Mix

Fig.28

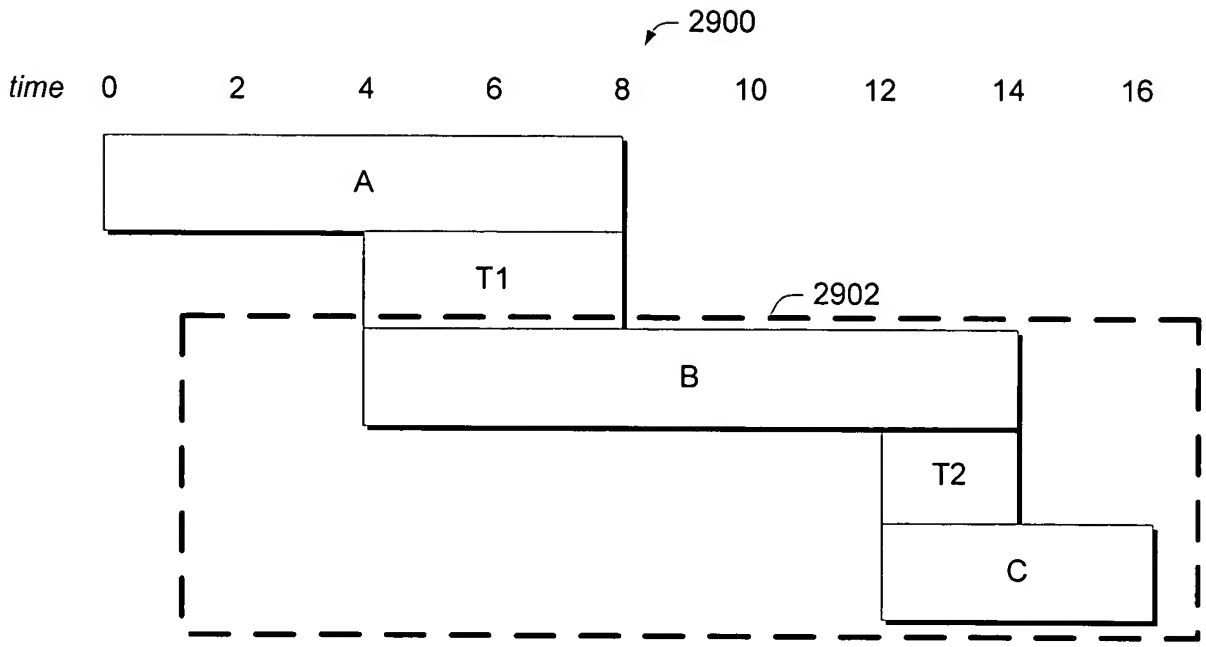

2900
time
0
2
4
6
8
10
12
14
16
A
T1
2902
B
T2
C

Fig.29

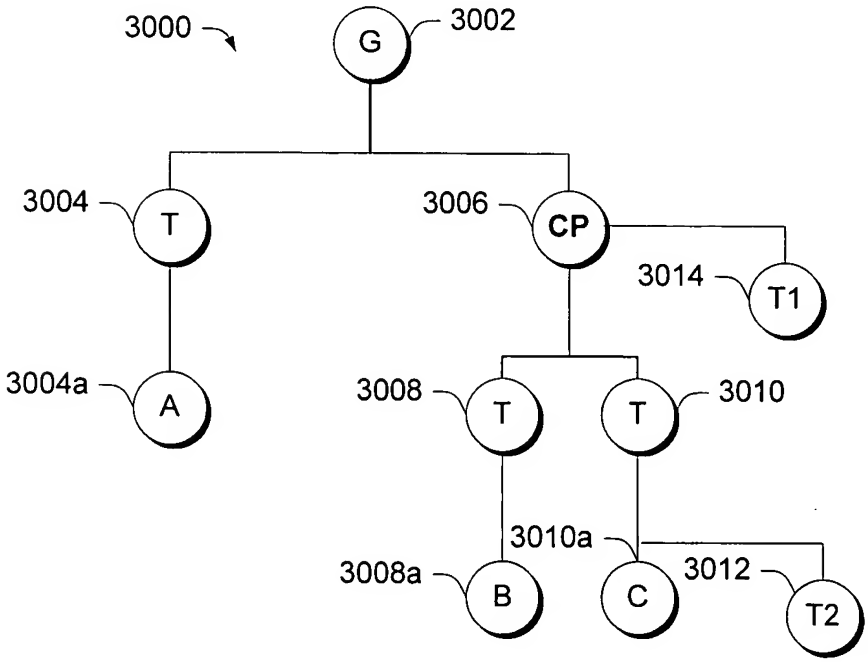

3000
G
3002
3004
T
3006
CP
3014
T1
3004a
A
3008
T
T
3010
3010a
3008a
B
C
3012
T2

Fig.30

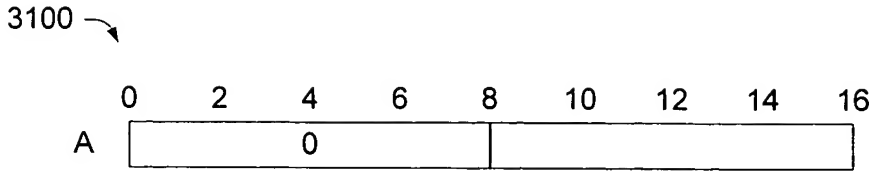


Fig.31

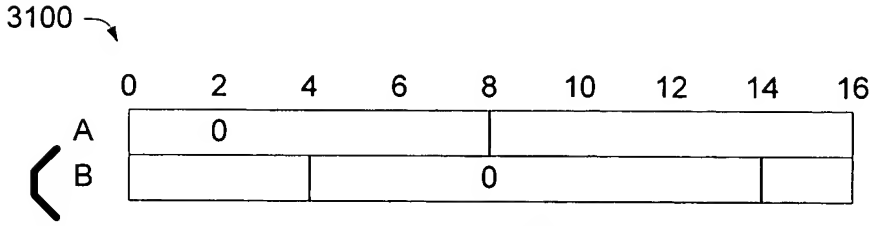


Fig.32

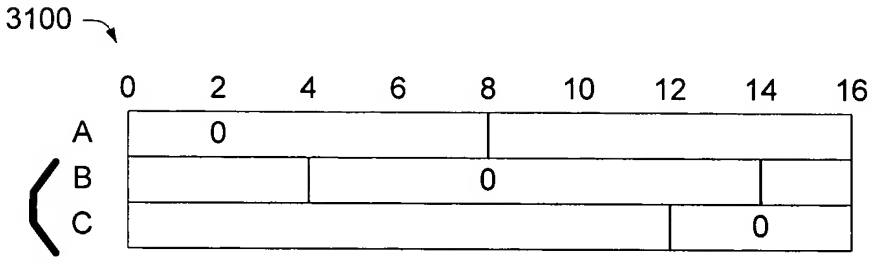


Fig.33

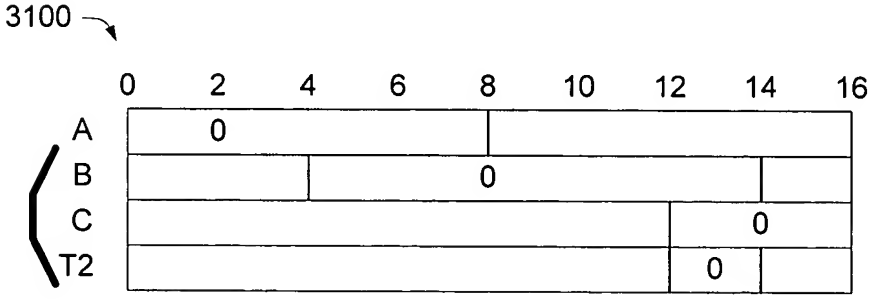


Fig.34

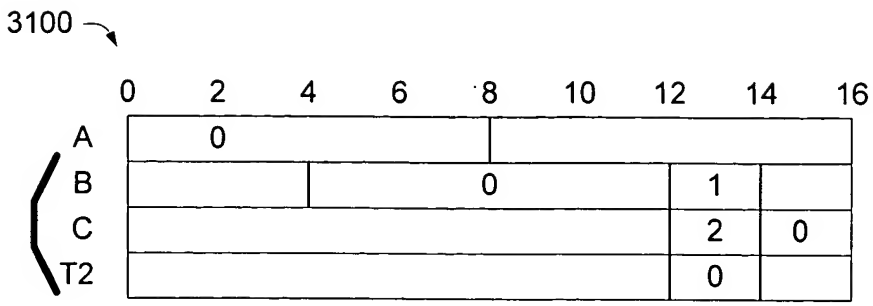


Fig.35

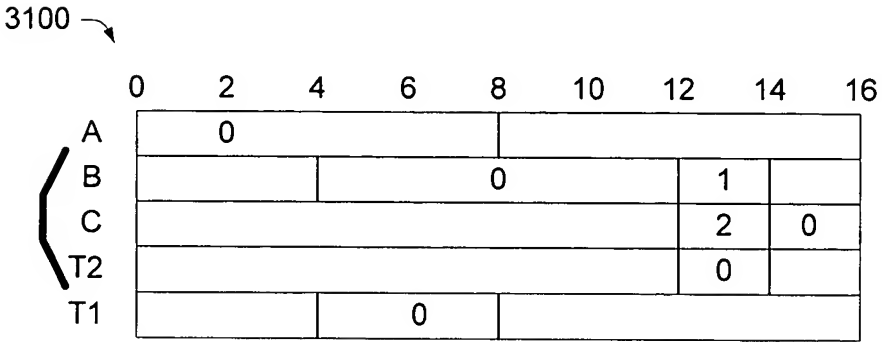


Fig.36

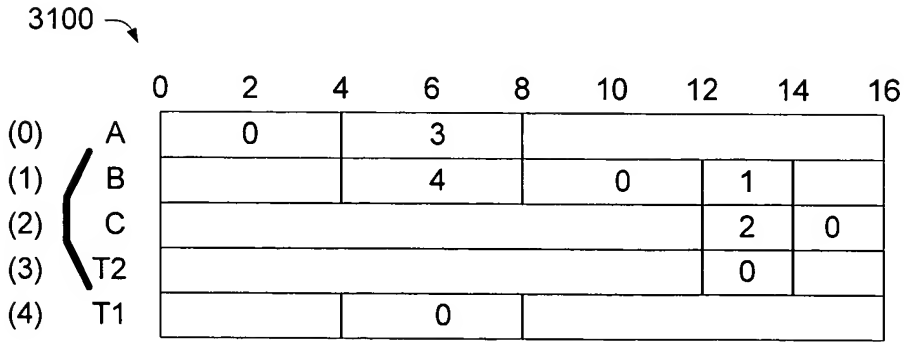


Fig.37

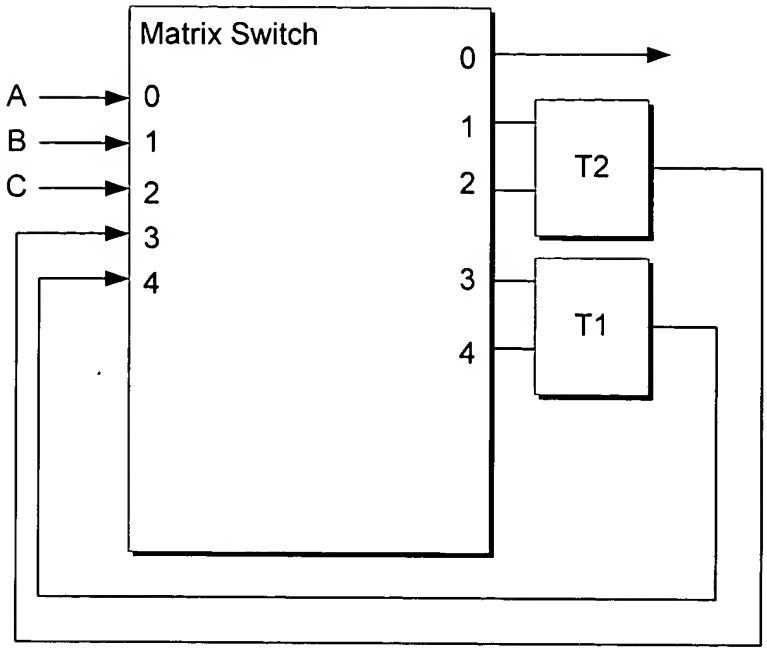

Matrix Switch
A
B
C
0
1
2
3
4
0
1
2
3
4
T2
T1

Fig.38

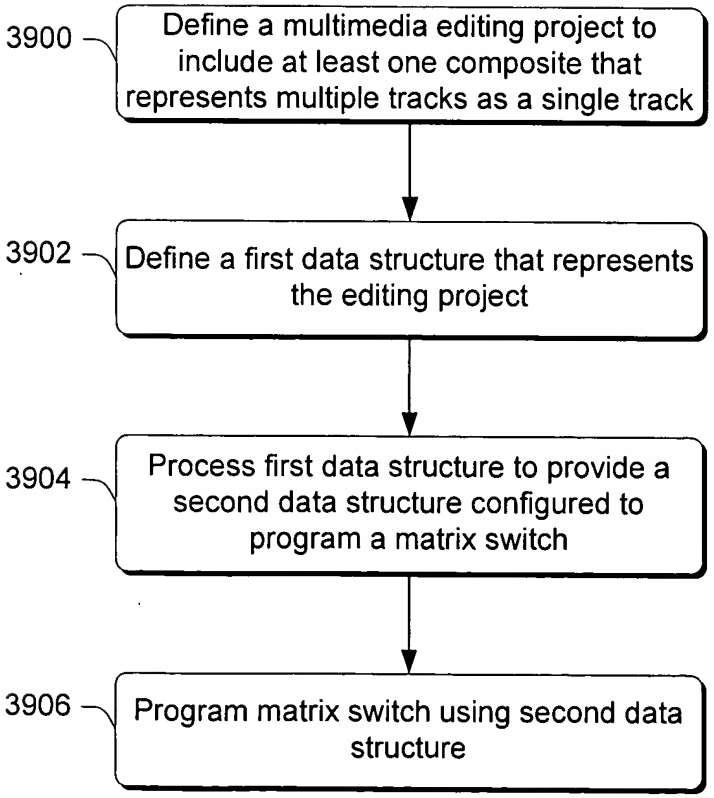

3900
Define a multimedia editing project to include at least one composite that represents multiple tracks as a single track
3902
Define a first data structure that represents the editing project
3904
Process first data structure to provide a second data structure configured to program a matrix switch
3906
Program matrix switch using second data structure

Fig.39

Fig. 40

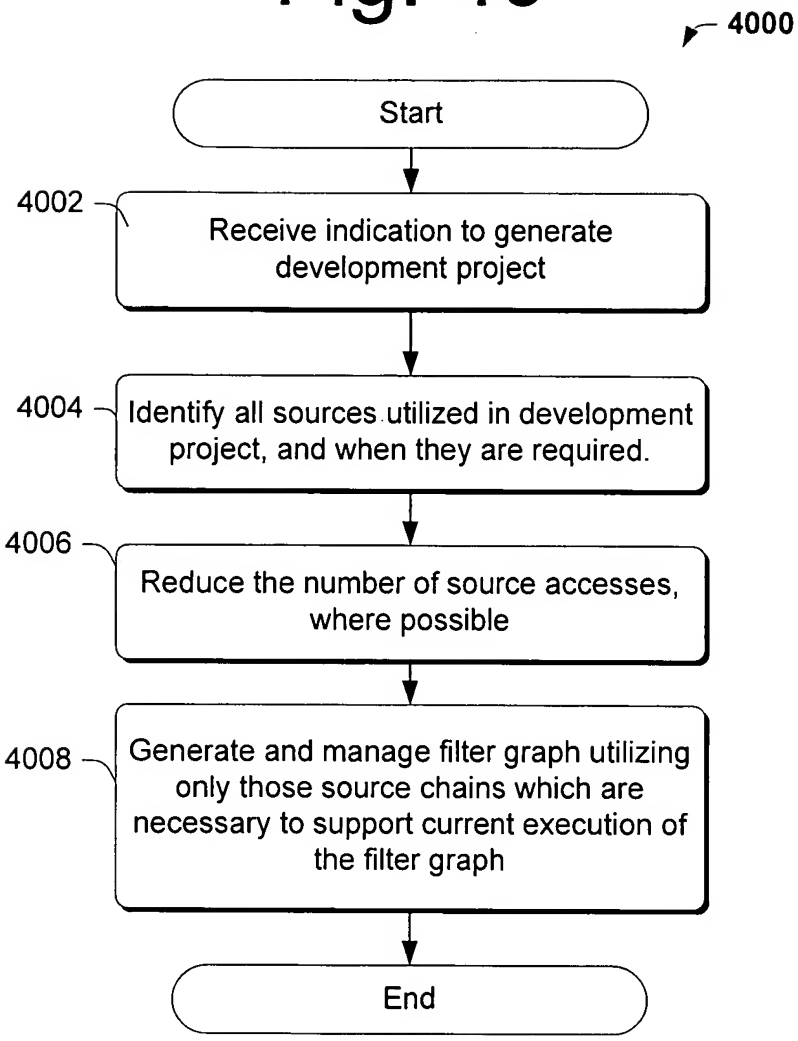

4000
Start
4002
Receive indication to generate development project
4004
Identify all sources utilized in development project, and when they are required.
4006
Reduce the number of source accesses, where possible
4008
Generate and manage filter graph utilizing only those source chains which are necessary to support current execution of the filter graph
End

Fig. 41

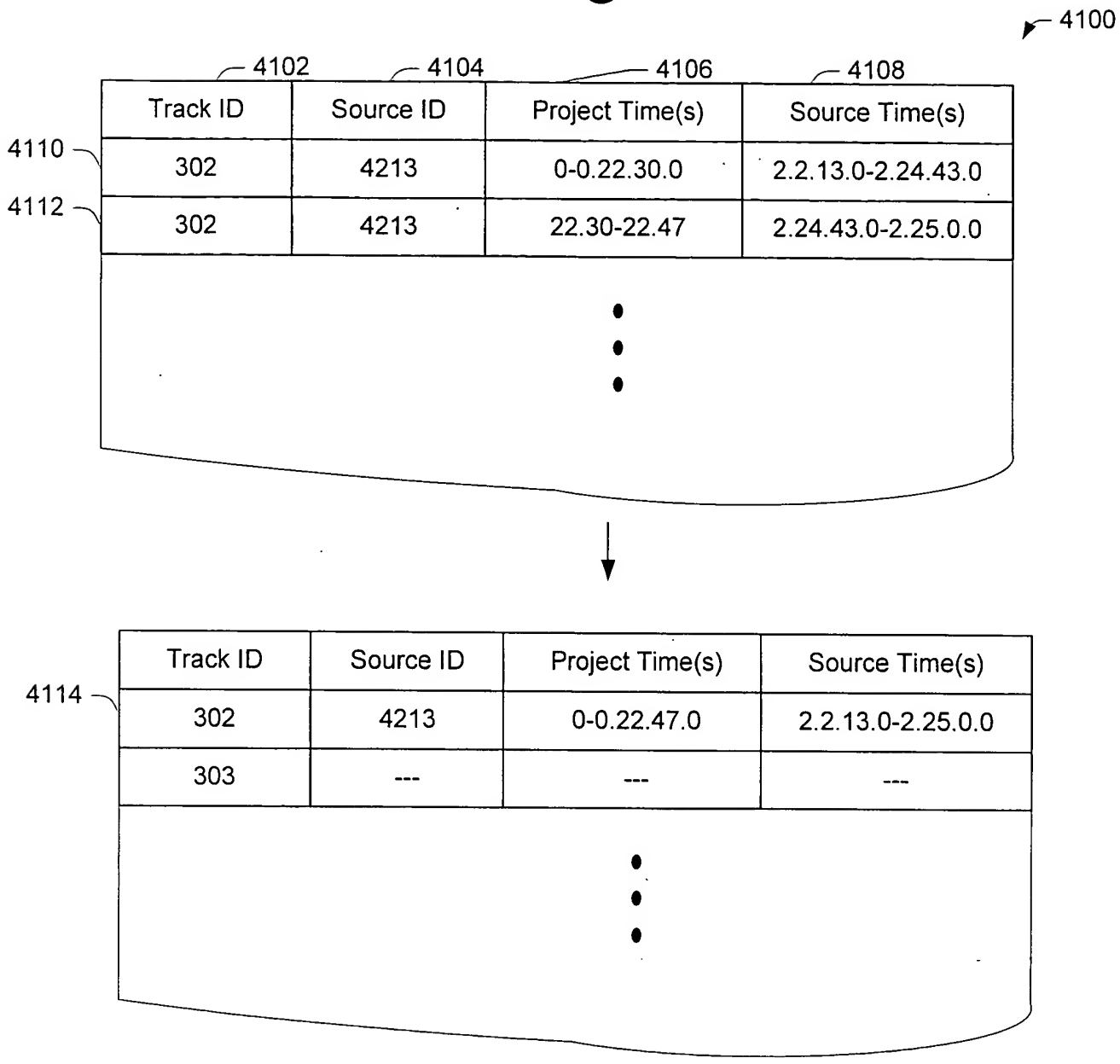

4100
4102
4104
4106
4108
Track ID
Source ID
Project Time(s)
Source Time(s)
4110
302
4213
0-0.22.30.0
2.2.13.0-2.24.43.0
4112
302
4213
22.30-22.47
2.24.43.0-2.25.0.0
4114
Track ID
Source ID
Project Time(s)
Source Time(s)
302
4213
0-0.22.47.0
2.2.13.0-2.25.0.0
303

Fig. 42

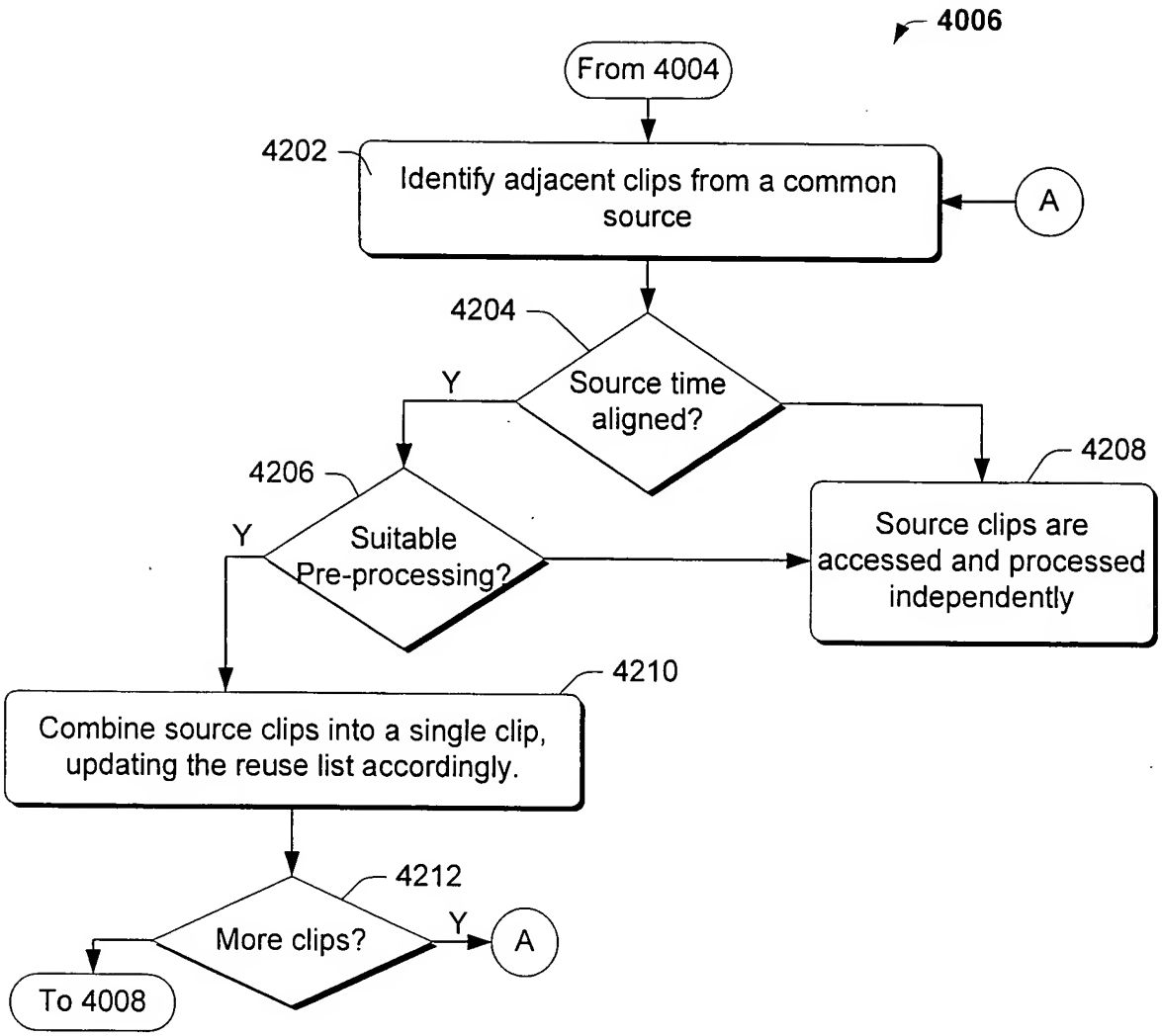

4006
From 4004
4202
Identify adjacent clips from a common source
A
4204
Source time aligned?
Y
4206
Suitable Pre-processing?
Y
4208
Source clips are accessed and processed independently
4210
Combine source clips into a single clip, updating the reuse list accordingly.
4212
More clips?
Y
A
To 4008

Fig. 43

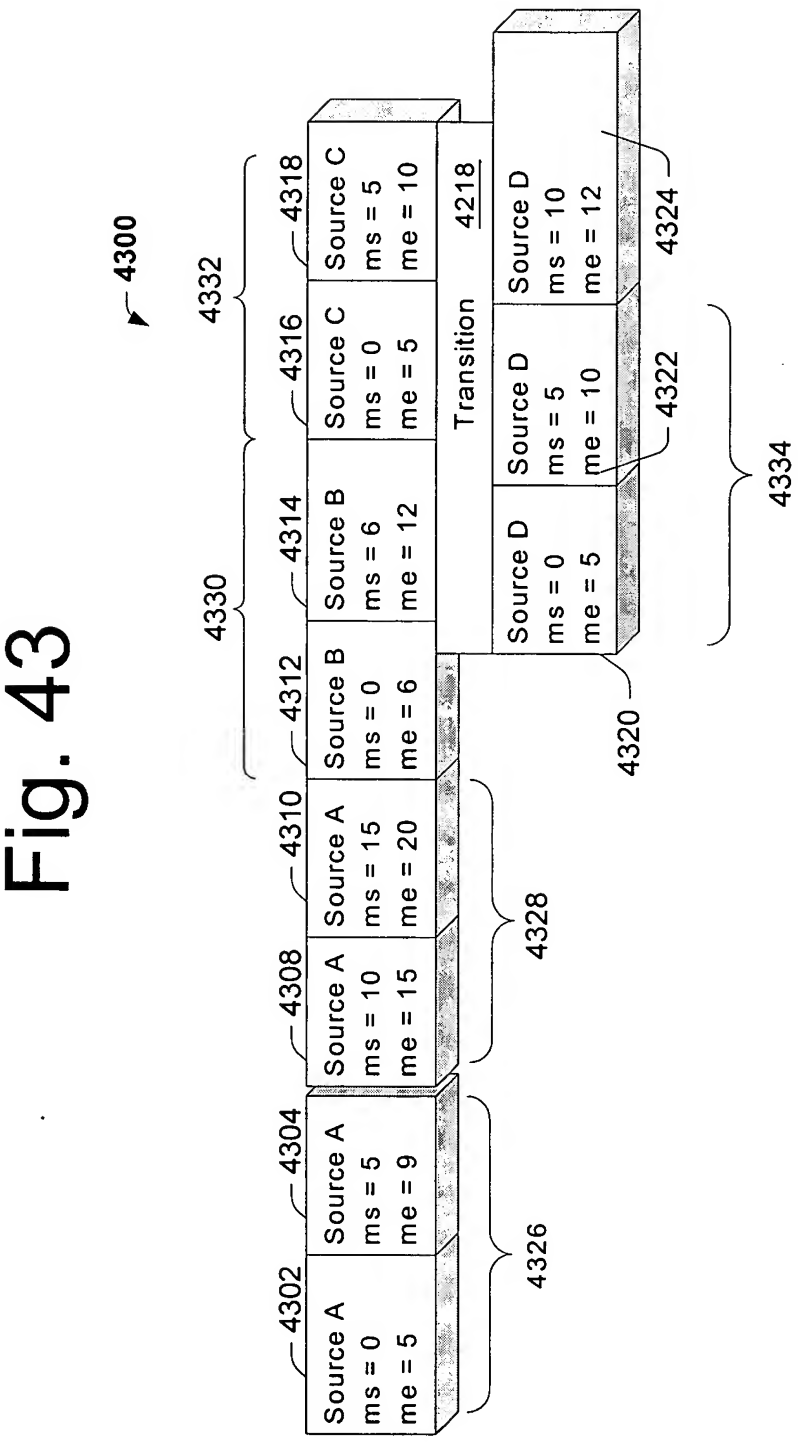

4300
4302
Source A
ms = 0
me = 5
4304
Source A
ms = 5
me = 9
4308
Source A
ms = 10
me = 15
4310
Source A
ms = 15
me = 20
4312
Source B
ms = 0
me = 6
4314
Source B
ms = 6
me = 12
4316
Source C
ms = 0
me = 5
4318
Source C
ms = 5
me = 10
Transition 4218
4320
Source D
ms = 0
me = 5
Source D
ms = 5
me = 10
4322
Source D
ms = 10
me = 12
4324
4326
4328
4330
4332
4334

Fig. 44

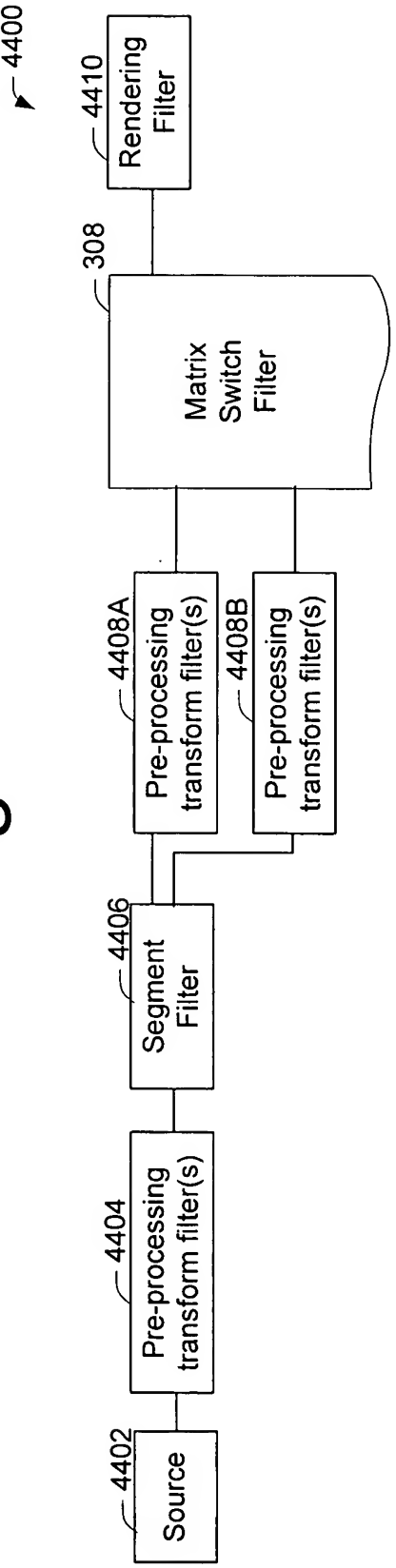

4400
4410
Rendering Filter
308
Matrix Switch Filter
4408A
Pre-processing transform filter(s)
4408B
Pre-processing transform filter(s)
4406
Segment Filter
4404
Pre-processing transform filter(s)
4402
Source

Fig. 45

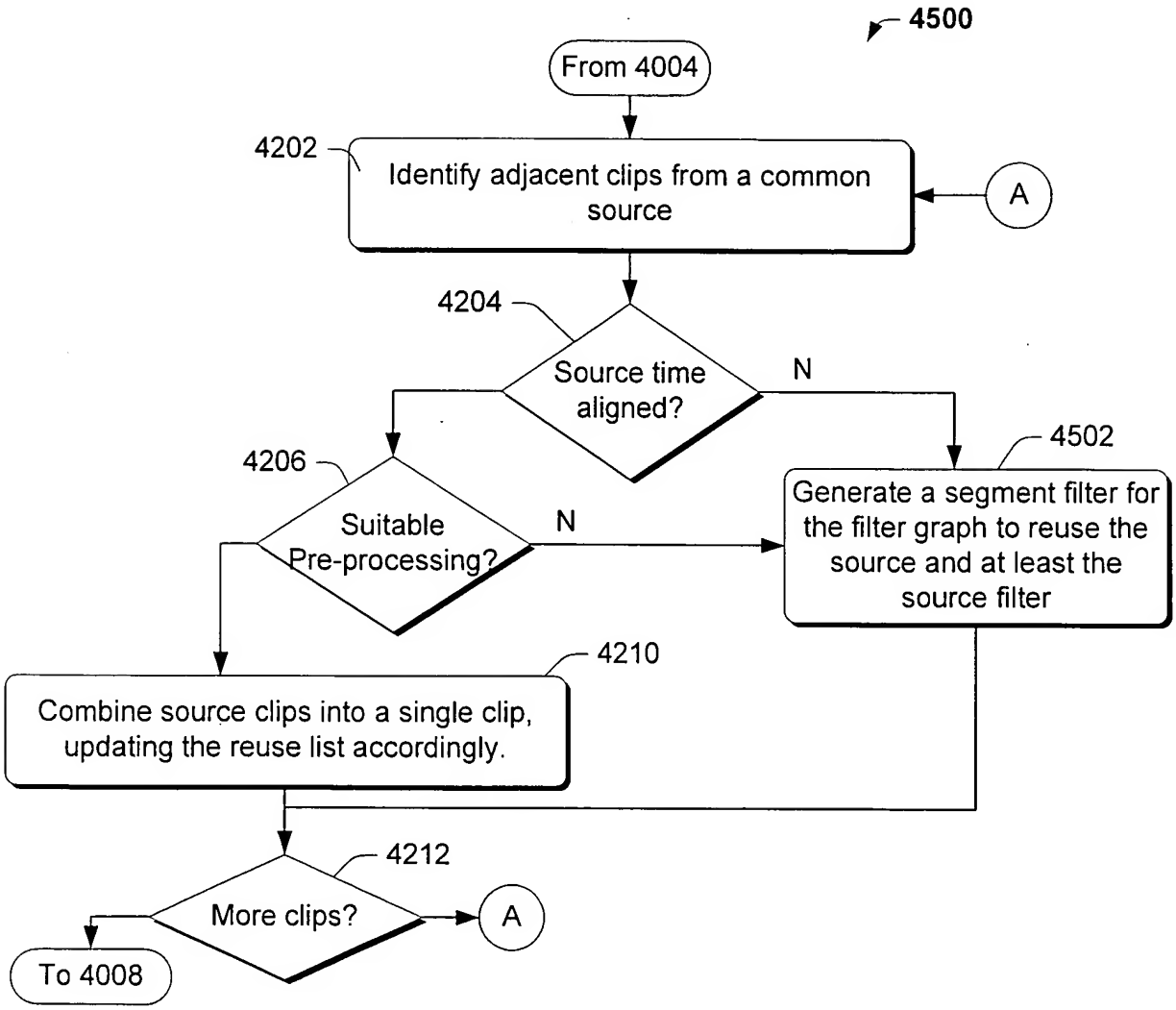
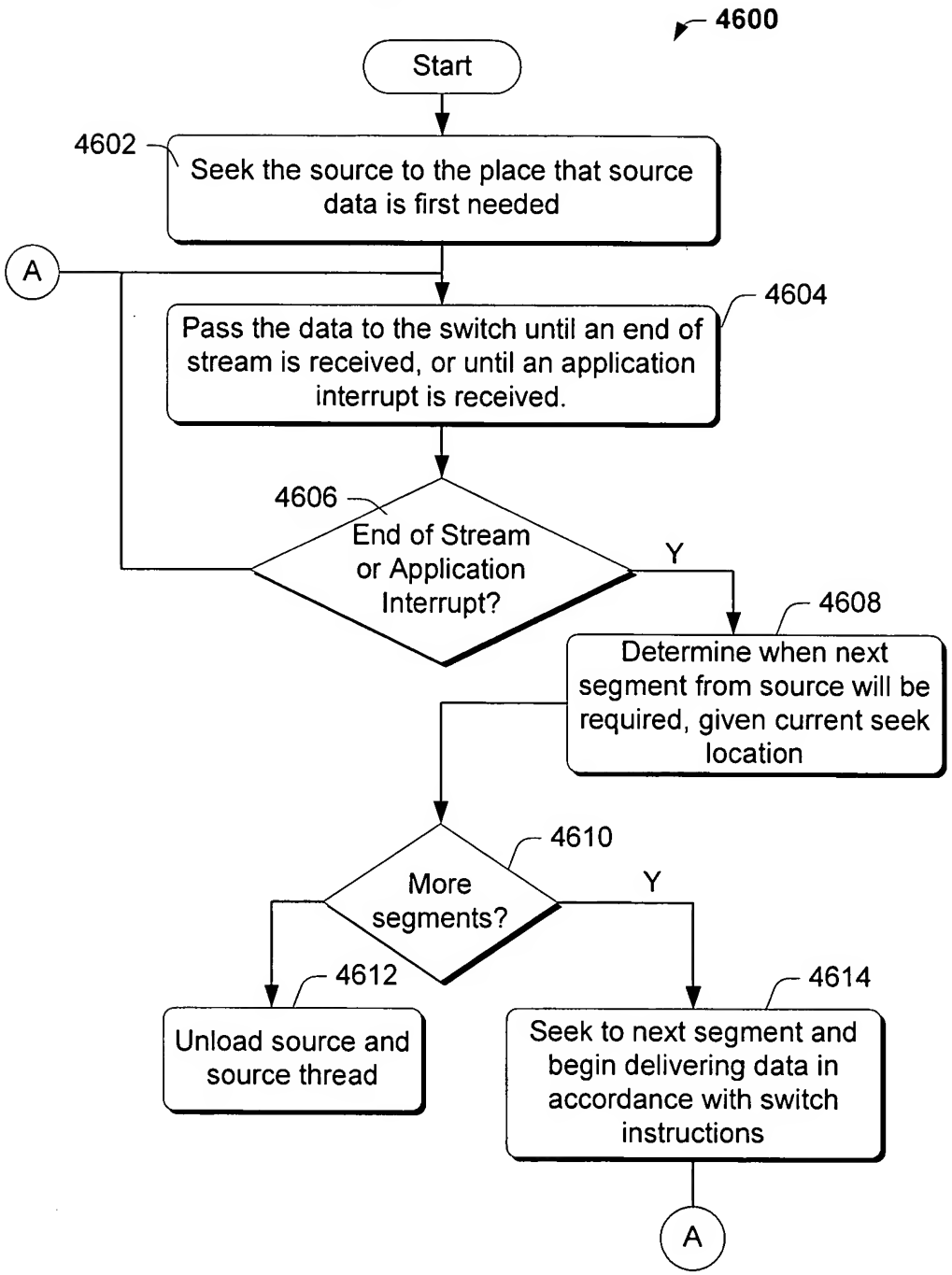

4500
From 4004
4202
Identify adjacent clips from a common source
A
4204
Source time aligned?
N
4206
Suitable Pre-processing?
N
4502
Generate a segment filter for the filter graph to reuse the source and at least the source filter
4210
Combine source clips into a single clip, updating the reuse list accordingly.
4212
More clips?
A
To 4008

Fig. 46


4600
Start
4602
Seek the source to the place that source data is first needed
A
4604
Pass the data to the switch until an end of stream is received, or until an application interrupt is received.
4606
End of Stream or Application Interrupt?
Y
4608
Determine when next segment from source will be required, given current seek location
4610
More segments?
Y
4612
Unload source and source thread
4614
Seek to next segment and begin delivering data in accordance with switch instructions
A